The Influence of Impurities on the Properties , of the Cr/Au and Cr/CrN/Au Structures

Donald Lie], Elzbieta Kolawa[1], Robert De Angelis[2]
Lynn Lowry[2] and John Scott-Monck[2]

[1]California Institute of Technology
Applied Physics 116-81
Pasadena, CA 91125
818356-6555
818356-2944 FAX
e-mail: eak@iago.caltech.edu

[2]Jet Propulsion Laboratory
Space Materials Science
4800 Oak Grove Drive
Pasadena, CA 91009

Gold thin films deposited on insulators or semiconductors are used extensively as conductor layers in many microelectronic applications. Typically **gold does not adhere well to a substrate** and a thin underplayer of chromium is used to provide the bond. The impact of impurities in the chromium on the chromium /gold diffusion characteristics and the mechanical performance of the thin film has been investigated.

Chromium (70 nm) and gold (600 run) layers were deposited by rf sputtering at 1.1×10^{-6} torr (sample set A) and at 1.5×10^{-7} (sample set B) on inert substrates and carbon. These different deposition conditions were chosen because of the expected difference in the level of impurities. The amount of the impurities were measured using backscattering spectrometry of the samples deposited on carbon. The samples were annealed in vacuum between 200°C and 500°C for 30 minutes and at 200°C for 10 hrs. The samples were characterized by Rutherford backscattering spectrometry (RBS), sheet resistance measurements, transmission electron microscopy, and x-ray diffraction, X-ray techniques were used to determine film stress. The interface structure was correlated with adhesion as measured by standard peel tests.

Using backscattering spectrometry, interdiffusion of gold and chromium was already observed after annealing at 200°C for 30 minutes in both sample sets, There was no detectable difference in the RBS spectra of sets A and B. For both sample sets the measured sheet resistance remained the same after annealing at 200°C (Figure 1). A significant increase in sheet resistance was measured after annealing the samples at 400°C. This increase corresponded with the complete consumption of the chromium layer by the gold (Figure 2), as observed by backscattering spectrometry. Only nominal changes were seen in backscattering spectra and sheet resistance with further increases in the annealing temperature. There was no detectable difference in the behavior of sample sets A and B.

These results indicated that the interdiffusion and electrical properties of the chromium gold bilayer structure are not affected by differences in base pressure during deposition. Similar studies are being conducted on samples deposited at ultra high vacuum (10^{-9} torr) and the results will be reported.

In order to suppress the interdiffusion of chromium and gold, a thin layer of reactively sputtered chromium nitride will be incorporated into the structure. The impact of this diffusion barrier layer on the electrical and mechanical performance of the structure will be reported.

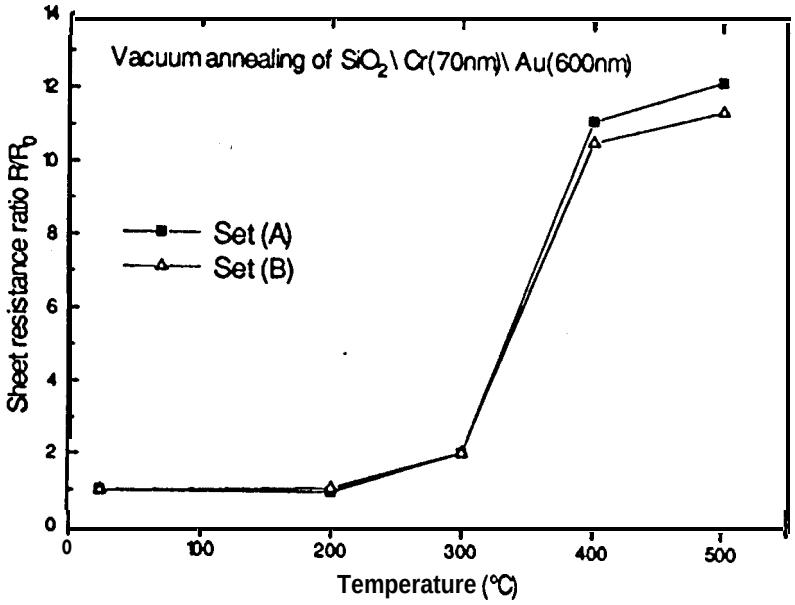
Vacuum annealing of SiO_2\ Cr(70nm)\ Au(600nm)
Set (A)
Set (B)
Sheet resistance ratio R/R_0
Temperature (°C)
0
2
4
6
8
10
12
14
0
100
200
300
400
500

Fig. 1

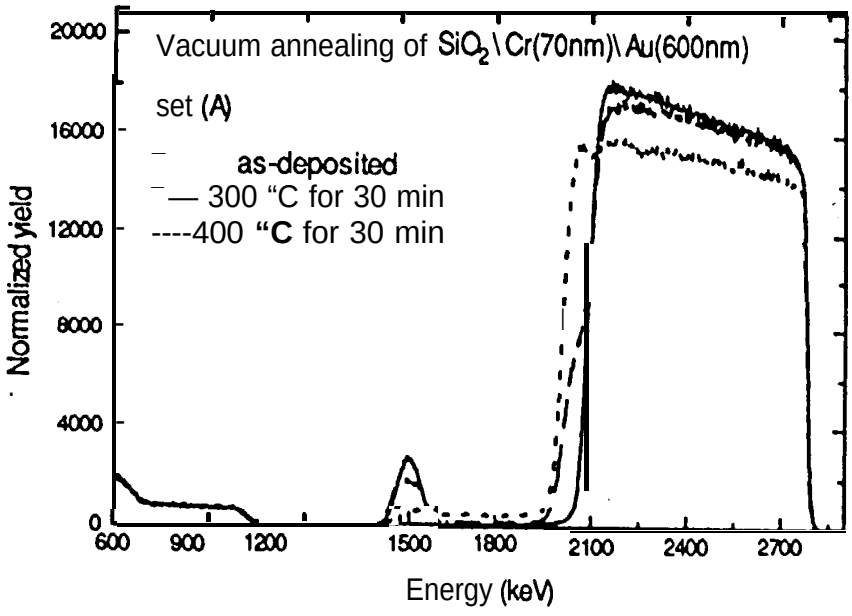
Vacuum annealing of SiO_2\ Cr(70nm)\ Au(600nm)
set (A)
as-deposited
— 300 °C for 30 min
----400 °C for 30 min
Normalized yield
Energy (keV)
0
4000
8000
12000
16000
20000
600
900
1200
1500
1800
2100
2400
2700

Fig. 2